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THE WORK OF THE YUMA RECLAMATION PROJECT EXPERIMENT FARM IN 1914.[1]

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INTRODUCTION.

Agricultural possibilities on the Yuma Reclamation Project include a great variety of crops. The growth and behavior of these crops are in most respects the same as on other large areas of irrigated land along the lower Colorado River. The average annual rainfall is between 2 and 3 inches and is seldom a factor in crop production. Summer temperatures are high and the winters are mild. The average frost-free period of 8½ months makes possible the culture of many types of long-season plants. Several crops which do well farther north are not adapted to this region because of the intense summer heat, but a few crops from cooler climates thrive well as winter crops in the lower Colorado River region.

Certain alkaline-soil and high ground-water conditions present problems in localized areas which limit the variety of crops that may be profitably produced on these areas. With small holdings of land and favorable climatic conditions, much intensive farming is possible.

[1] The Yuma Experiment Farm is located on the Yuma Reclamation Project, 7 miles north of Yuma, Ariz., and adjacent to Bard, Cal. It consists of 160 acres of land, all of which is irrigable. The land was withdrawn from entry in 1909 by the Department of the Interior, to be used as an experiment farm. Operations on the farm were begun in the spring of 1910. A farmhouse and an office building were constructed by the United States Reclamation Service; a tool house and a machine house have been built by the United States Department of Agriculture. The farm is under the direct supervision of a superintendent detailed from the Office of Western Irrigation Agriculture, Bureau of Plant Industry, and that office furnishes the funds necessary to maintain the farm.

Other offices of the Bureau of Plant Industry have cooperated in conducting various experiments during the year. The Office of Acclimatization and Adaptation of Crop Plants has cooperated in breeding and cultural experiments with cotton. The Office of Crop Physiology and Breeding Investigations cooperates in breeding and variety-test work with figs, dates, and other horticultural crops. The Office of Foreign Seed and Plant Introduction has supplied various exotic fruit and ornamental and vegetable plants that are being tested. Investigational work with grain sorghums and flax is cooperative with the Office of Cereal Investigations and that on Sudan grass with the Office of Forage-Crop Investigations. The Office of Alkali and Drought Resistant Plant Investigations is cooperating in breeding and varietal work with pomegranates. The meteorological observations are made in cooperation with the Biophysical Laboratory.

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The work of the Yuma Experiment Farm is planned to throw light on the problems common to agriculture in the lower Colorado River region. Many experiments under way have been continued from former seasons, and others have been inaugurated during 1914. Breeding, variety tests, and cultural experiments have been conducted with various field crops. Production and variety tests of vegetables have been included. Many varieties of fruits, nuts, and perennial ornamentals are also being tested. This paper reports the

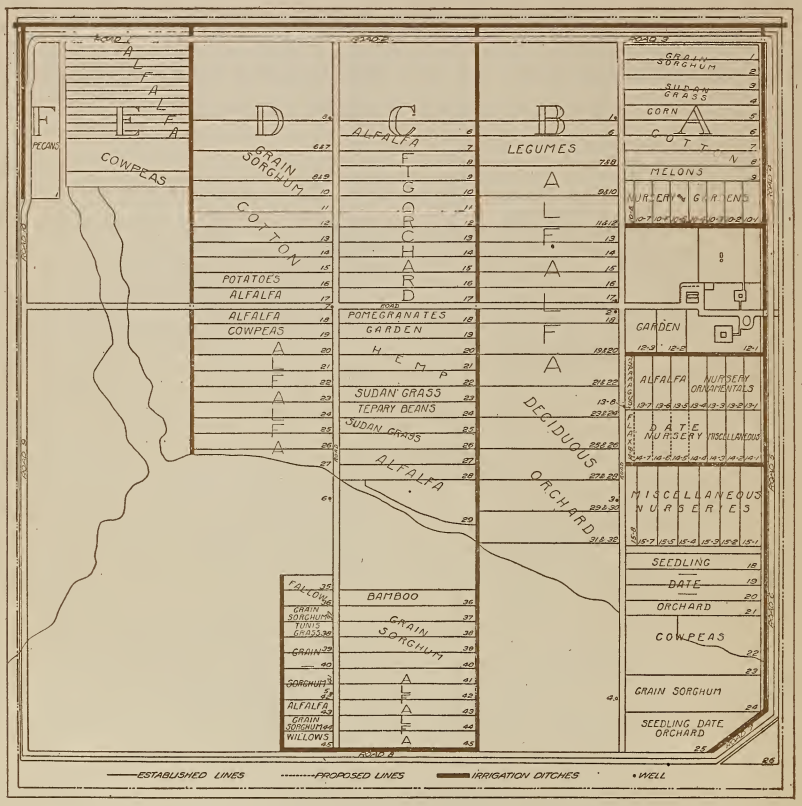

FIG. 1.—Diagram showing the arrangement of the fields and the location of the experiments at the Yuma Experiment Farm in 1914.

more important features of the work during the year 1914 and discusses briefly the development of agricultural industries on the Yuma project. The arrangement of the fields and the location of the experiments are shown in figure 1.

FARM BUILDINGS AND IMPROVEMENTS.

The fencing of the experiment farm is now entirely completed. During the year 1914, provisions for more efficient propagation work and study of water requirements were provided by erecting a 7,000-

gallon tank for the storage of ditch water, to be used when the regular irrigation water is not available.

Living conditions for the men at the experiment farm were improved by the installation of a small water still and also by the erection of a specially designed sleeping house, which is inexpensive but comfortable. This building is 30 by 36 feet, floor space, with an 8½-foot ceiling. The walls are all screen wire on the east, west, and south, which are the windward sides, and equipped with khaki canvas curtains arranged to be raised to any height from the base, to allow air circulation or afford shelter, as desired. The floor slopes from the center to the edges and may be flushed out with a hose when the baseboards are lifted. The ceiling is of canvas, drawn taut and supported by wires attached through rings sewed to the canvas to give the desired ceiling pitch. An air space of 24 inches is allowed for circulation between

FIG. 2.—An inexpensive but comfortable sleeping house at the Yuma Experiment Farm. This type of house appears to be well adapted to the conditions in the lower Colorado River region.

the ceiling and the roof, all eaves being open. The roof is formed of native tule, thatched and sewed to 1 by 4 inch sheathing with small copper wire. This type of roof is expensive only in labor of construction and is perhaps the most comfortable protection during the hot summer of any available material. Such a building would not be of any value in a humid climate, but it seems to be very satisfactory under desert conditions. The building is illustrated in figure 2.

CONDITIONS ON THE PROJECT.

Climatic conditions.—During the year the weather conditions were generally favorable for farm operations and crop growth except during the months of November and December, when the precipitation was much above normal. Much hay in the stack, not protected

against rain, was damaged during those months. Precipitation during the year 1914 was 5.63 inches, more than double the average annual rainfall of the preceding four years. Four months during the summer were without rain, there being two rainless periods of 83 and 65 days, respectively.

Table I presents a condensed summary of climatological observations recorded at the experiment farm during the 5-year period, 1910 to 1914, inclusive.

TABLE I.—*Summary of meteorological observations at the Yuma Experiment Farm, 1910 to 1914, inclusive.*

PRECIPITATION (INCHES).

Year, etc.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Average for 5 years, 1910 to 1914	0.155	0.37	0.48	0.20	0.15	0.104	0.30	0.18	0.112	0.39	0.54	0.24	3.22
For 1914	.095	.35	.98	.27	.00	.00	.28	.00	.00	.90	1.55	1.20	5.625

EVAPORATION (INCHES).

Average for 5 years, 1910 to 1914	3.34	4.20	6.68	6.63	9.84	10.67	10.02	9.81	8.05	5.91	3.87	2.90	81.91
For 1914	2.924	3.835	5.917	6.204	8.589	10.50	10.14	10.24	7.55	5.003	2.95	1.88	75.81

DAILY WIND VELOCITY (MILES PER HOUR).

1910	.....	.....	.....	.....	4.1	3.8	3.6	3.4	2.4	3.7	3.3	3.5	.....
1911	3.0	3.5	2.7	3.8	3.3	2.9	2.5	2.0	1.7	2.5	3.7	3.5	.....
1912	3.2	4.0	3.9	3.8	3.3	2.6	2.3	2.1	3.1	3.0	2.9	4.0	.....
1913	3.1	3.3	4.1	3.1	2.4	2.1	2.1	2.1	2.0	1.9	1.8	2.1	.....
1914	2.85	3.4	3.0	3.3	2.4	2.3	1.9	2.2	1.7	1.6	1.05	1.75	.....

MONTHLY TEMPERATURE (° F.).[1]

Absolute maximum:													
5 years, 1910 to 1914	84	88	96	106.5	120	117	116	113.5	116	107	94	81	120
For 1914	79.5	83	96	102	104	112	109	113.5	108	99	91	79	113.5
Absolute minimum:													
5 years, 1910 to 1914	16	27	30	32	35	47	55	57	48	36	28	16	16
For 1914	30	27	31	41	49	51	60	60	55	44	36	25	25
Mean:													
5 years, 1910 to 1914	53.1	55.2	61.7	68.4	76.1	81.2	87.2	88.3	82.5	70.1	61.2	50.6	69.6
For 1914	55.7	57.4	65.6	69.1	73.5	80.9	88.5	87.8	82.5	71.0	63.8	48.3	70.34

KILLING FROSTS.

Year.	Last in spring.		First in autumn.		Frost-free period.
	Date.	Minimum temperature.	Date.	Minimum temperature.	
		° F.		° F.	Days.
1910	.....	.....	Nov. 27	32	.....
1911	Feb. 24	32	Nov. 24	32	262
1912	Mar. 31	32	Dec. 4	31	247
1913	Mar. 28	32	Dec. 2	31	248
1914	Mar. 4	31	Dec. 4	32	275

[1] Records of maximum and minimum temperatures date from Apr. 21, 1910.

Evaporation was about normal, as were also the mean temperatures. The lowest minimum of only 25° F., occurring on December 28, permitted many tender plants to pass through the winter with normal growth. There were 275 days without frost, which is the longest frost-free period for five years, since this station was established.

Crop conditions.—In some respects the crop conditions of 1914 were better than in previous years, but there were some difficulties, one of the most important of which was that the area subject to seepage was again seriously damaged by ground water during June, when the Colorado River stood against the levees for several weeks. During the season 25,207 acres were irrigated on 698 farms, while 35,685 acres were reported irrigable. Of this irrigated area 2,639 acres were new land and unbearing orchard, leaving 22,568 acres of cropped land. This cropped area is 5,842 acres greater than in 1913. The total farm value of all crops on the project was $709,409, as compared with $610,228 in 1913. The average farm value per acre was $31.43, as compared with $36.48 the preceding year. The acreage, yields, and farm values of the crops grown on the project in 1914 are shown in Table II, these figures being obtained from the Reclamation Service.

TABLE II.—*Acreage, yields, and farm values of the crops on the Yuma Reclamation Project in 1914.*

Crop.	Area.	Unit of yield.	Yield.			Farm value.		
			Total.	Per acre.		Per unit of yield.	Total.	Per acre, average.
				Average.	Maximum.			
	Acres.							
Alfalfa hay	10,426	Ton	32,525	3.12	9	$6.05	$196,710	$18.86
Other hay	671	do	1,067	1.6	2	7.64	8,150	12.15
Alfalfa seed	5,485	Pound	246,318	227	850	.13	159,806	29.15
Barley	1,653	Bushel	48,946	29.6	65	.58	28,590	17.29
Wheat	570	do	12,710	22.3	60	1.00	12,783	22.43
Grain sorghums	3,066	do	100,153	32.6	90	.70	70,915	23.13
Corn	257	do	8,595	33.4	70	.65	5,584	21.71
Cane and corn fodder	551	Ton	993	1.8	5	7.45	7,397	13.42
Cotton	2,268	Pound	845,044	373	1,000	.08	69,867	30.80
Cotton seed	2,268	Ton	728	.32	1	11.77	8,572	3.78
Beans	128	Bushel	2,025	15.8	35	2.24	4,531	35.40
Truck	314	Acre					18,377	58.52
Fruit	40	do					4,080	102.00
Pasture	7,058	do					87,061	12.33
Additional revenue from pasturing alfalfa, thrashed straw, and stalk lands during winter							26,980	2.00
Less duplications	12,187							
Total cropped	22,568						709,409	
Value per acre								31.43

Table III shows the annual acreage, production, and farm values of the principal crops produced from 1911 to 1914, inclusive. The figures in this table were obtained from the Reclamation Service.

TABLE III.—*Acreage, production, and farm values of the crops grown on the Yuma Reclamation Project from 1911 to 1914, inclusive.*

Item and year.	All crops.	Alfalfa hay.	Alfalfa seed.	Grain sorghums.	Wheat and barley.	Cotton.
Acreage:						
1911	8,570	3,750	[a] 2,600	420	1,290	30
1912	4,060	7,269	2,824	986	1,567	25
1913	16,726	10,321	3,388	2,928	1,585	62
1914	22,568	10,426	5,485	3,066	2,223	2,268
Production:		*Tons.*	*Pounds.*	*Bushels.*	*Bushels.*	*Pounds.*
1911		16,327	576,730	13,106	39,083	15,000
1912		27,078	814,186	31,372	55,375	5,800
1913		38,100	1,139,100	112,597	45,075	19,610
1914		32,525	1,246,318	100,153	61,674	845,044
Average yield per acre:						
1911		4.36	222	31.5	30.6	500
1912		3.73	288	31.8	35.3	232
1913		3.69	336	38.5	28.4	316
1914		3.12	227	32.6	27.8	373
Farm value per unit of yield:						
1911		$15.00	$0.16	$0.854	$0.66	$0.20
1912		10.00	.10	.75	.75	.20
1913		7.53	.111	.513	.668	.21
1914		6.05	.13	.70	.676	[b] .08
Farm value per acre:						
1911	$51.80	65.44	35.52	23.62	20.20	100.00
1912	44.94	37.30	28.80	23.85	26.47	46.40
1913	36.48	27.83	37.33	19.72	18.95	66.50
1914	31.43	18.86	29.15	23.13	21.13	30.80
Total farm value:						
1911	443,984.00	244,905.00	92,276.00	11,180.00	25,775.00	3,000.00
1912	497,012.85	270,780.00	81,418.60	23,529.00	41,517.00	1,160.00
1913	610,228.00	287,195.00	126,450.00	57,740.00	30,131.00	4,123.00
1914	709,409.00	196,716.00	159,806.00	70,915.00	41,373.00	78,399.00

[a] This area is included in the alfalfa hay acreage in 1911.
[b] The average farm value of cotton in 1914 was low, because of the general depression in the cotton markets and also because a large proportion of the cotton grown on the project that year was short staple.

The crops produced on the Yuma project may be classified as major crops and minor crops. In the major-crops group are alfalfa for hay, for seed, and for live-stock pasturing; also cotton and grains. The group of minor crops includes vegetables and truck crops, dates, and some other crops which can be produced only in a limited way, owing to special conditions affecting their production or marketing.

In 1914 alfalfa for hay was not so good a crop on the entire project as in years past. Less hay was produced than during 1913, largely on account of the greatly increased area pastured, and a somewhat lower yield per acre was harvested. The price of alfalfa hay was low, due possibly to an overproduction of hay and too few feeding cattle. Adjacent irrigated valleys have a large percentage of their cultivated area in this crop. Also, abundant precipitation in the rainfall pasture area in the coast region of southern California reduced the demand for alfalfa hay in that section.

Alfalfa seed was produced on a larger area than in 1913, but the yields were much lighter. Late cuttings of seed were heavily infested with the chalcis fly. While the price was only 11 cents per pound in 1913, the average price for 1914 was 13 cents. Alfalfa seed will continue to be one of the best money crops of this section.

Alfalfa seed has been marketed by many growers for the past six years through a cooperative association. Local dealers have also bought and sold quantities of seed, especially during 1914, competing very keenly with the cooperative association. Such selling associations are highly desirable to the farmer, as they assist him in getting a reasonable price for his produce. The season of 1913 proved to be an exceptionally good one for seed production. In Table IV is listed a record of alfalfa-seed yields during that year, as kept by the manager of a local thrashing machine.

TABLE IV.—*Yields of seed of alfalfa thrashed by one machine on the Yuma Reclamation Project in 1913.*

Variety.	Crop left for seed.	Number of fields.	Acreage.	Total yield.	Average yield per acre.
				Pounds.	*Pounds.*
Chilean	Second..	43	446	182,257	409.0
Peruvian	...do....	9	80.25	36,303	452.2
Chilean	Third...	3	21	2,621	194.9
Peruvian	...do....	3	22	2,836	123.8

The economic need for feeding alfalfa to live stock is emphasized when market values for the past four years are compared. During 1911 and 1912 all alfalfa hay for sale was marketed to contractors while the greater part of the construction work on the Yuma project was being done. As hay production for the past two years has increased and the number of work stock being fed has decreased, a great quantity of hay has been marketed off the project.

Table V shows the total production and market value of alfalfa hay on the Yuma project for the past four years.

TABLE V.—*Total production and value of alfalfa hay on the Yuma Reclamation Project, 1911 to 1914, inclusive.*

Year.	Production.	Value per ton.
	Tons.	
1911	16,327	$15.00
1912	27,078	10.00
1913	38,100	7.53
1914	32,525	6.05

The live stock maintained on the Yuma project have been too few to consume all the alfalfa hay produced. Approximately 7,000 beef cattle were fattened during the past year and marketed at returns far in advance of marketing hay. Over 650 dairy cattle on the project have been reported. The local creamery company, which buys nearly the entire output of butter fat, during 1914 received 116,000 pounds at an average price of 27 cents per pound. A census shows a total increase in the value of dairy cattle and feeders of $49,500 over 1913.

A total of 4,982 hogs was reported on the project, which is an increase of 73 per cent in the past year. Fourteen hundred head of sheep were reported. Sheep raising is a new industry in this section. Much pasture is afforded for sheep along irrigation ditches wherever these are fenced.

Cotton will probably become one of the principal money crops of the Yuma project. For three years previous to 1914 Egyptian cotton was grown on a limited acreage on the California side of the project. During the spring of 1914 a circular was issued by the Department of Agriculture, describing the behavior of the different cotton varieties grown on this experiment farm and also in commercial quantities in neighboring valleys. Two very important facts were emphasized: (1) That the Yuma Valley is especially adapted for the culture of long-staple cotton, either Egyptian or Durango, and (2) that to establish a permanent and profitable industry, only one variety should be grown in the valley; otherwise, an admixture would soon result and depress the value of the long-staple fiber produced. In spite of these suggestions a great deal of short-staple cotton was planted, and this, together with the depression of the cotton markets, accounts for the much lower returns per acre from this crop in 1914 than in previous years, as is shown in Table III.

In 1914 Egyptian cotton was not planted on the California portion of the project, because of difficulties experienced in securing pickers for this variety. The cotton acreage of this area was planted to the Durango variety, which produced very good yields and a good quality of fiber where well grown. A cooperative association was organized among the growers to promote the marketing of Durango cotton and to establish the production of pure seed.

The grains most important for this area are the grain sorghums, which in point of production and as a finishing feed excel other grains that may be grown here. Barley and wheat are both grown to some extent, but they are less dependable than the grain sorghums. Corn can not be relied upon.

Fruit and truck must be considered as minor crops, although some growers will probably specialize in certain fruit and vegetable crops when the marketing problems are solved. Some fruits and vegetables yield enormous crops, but their production is limited by the lack of satisfactory marketing facilities. Very early varieties probably will be the most profitable. Date growing develops slowly, but will no doubt be profitable when the right varieties are planted. A fairly large acreage of dates not yet in bearing is now planted on the project.

Another promising minor industry is the production of seed of various annual plants. The climatic conditions of this area seem to provide the environment most desired by many families of plants

for maximum seed yields. To succeed in this venture a grower must necessarily devote much attention to a few strains and familiarize himself with the market demands for these seeds. The most notable example already carried out in this regard is the commercial production of Bermuda-grass seed on the Yuma project.

Farmers' organizations on the Yuma project, unfortunately, have been in the past poorly supported by members, thus lessening the efficiency of production and disposal. There are now two organizations on the project: The Yuma Valley Produce Growers' Association, in Arizona, and The San Pascual Valley Durango-Cotton Growers' Association, in California. The former is organized and incorporated under the laws of Arizona, with authority to handle many products and merchandise. However, of late years its business has been devoted entirely to recleaning and marketing alfalfa seed. The latter organization is of recent formation and has offered the opportunity of effective cooperative work during the past season with the Department of Agriculture in extending assistance to the growers in producing a pure strain of seed of Durango cotton for future plantings on the project. Two well-grown Durango fields were selected, where the plant development could be carefully observed, and at the proper season men experienced with this variety of cotton rogued from the fields the poor Durango and all other off-type plants. At the same time an effort was made to allow the growers who were interested in the improvement and study of this variety to avail themselves of the educational value of the work. It is very desirable that the distribution of this pure seed be made through the Durango association for the benefit of its members and eventually to provide for maintaining good seed through association control. Some cooperation was had with individual farmers by studying their local soil problems, mainly in efforts to wash alkali from the soil.

CROP EXPERIMENTS.

Investigational work at this station is conducted with consideration of three main problems: Local cultural and soil improvement problems are to be studied; better varieties are searched for among new introductions or the improvement of strains already being grown is attempted; and the general crop and cultural problems of adjacent Colorado River Valley lands are investigated.

COTTON.

The necessity of growing but one variety of cotton in a long-staple community has been emphasized to the grower. Durango was the variety grown in all cultural experiments at this station the past season. These experiments included thinning at various spaces, planting at varied distances of rows, planting at successive dates, from early April until July, and experiments in irrigation. Plantings at

varying distances have given rather uniform results in favor of rows 24 inches apart in an experimental plat, but these results are not considered sufficient to recommend this method of planting for commercial production. Some disadvantages, such as badly lodged and tangled plants at picking time, as shown in figure 3, are produced by close-row planting.

FIG. 3.—Field showing a rank growth of Durango cotton, badly lodged after a heavy crop had set, on the Yuma Reclamation Project in 1914.

In Table VI are recorded the results of this experiment. It will be noted that with one exception all plats that were thinned in the row to only 9 inches exceeded in yield the similar plats thinned to 12 inches. Other experiments indicate that the optimum thinning space is even less than 9 inches in the row.

TABLE VI.—*Durango cotton in a row-space and thinning test at the Yuma Experiment Farm in 1914.*

Space between rows.	Space between plants in rows.	Yield per acre of seed cotton (pounds).	
		Plat.	Average.
	Inches.		
36 inches	9	2,564	2,357
36 inches	12	2,149	
24 inches	9	2,623	2,667
24 inches	12	2,710	
18 inches	9	1,171	1,147
18 inches	12	1,123	
12 inches	9	1,626	1,497
12 inches	12	1,368	
9 inches	9	2,562	2,160
9 inches	12	1,757	

Planting dates for obtaining maximum yields must necessarily be determined from data collected during several seasons. A test conducted in 1914 indicated these limits. It also gave other general

facts of value. If good stands can be secured, the largest yields can be produced from plantings made between April 6 and May 4, the optimum dates being about April 14 to 22. To secure a good stand, however, is a very important factor in producing large yields. Very little difficulty is experienced in obtaining a good stand on a properly prepared seed bed during June and July, but low temperatures occurring during March and April often hinder perfect germination. When the average minimum temperature covering a period of 10 days following planting was below 52° F. no good stands were produced during 1914.

Factors other than low temperatures influencing poor stands are deep planting and the mistake of irrigating immediately after the cotton has been planted on soil that hardens when drying. The young cotton plant is not able to push its way through a hard soil crust without injury.

Observations and experiments indicate that the main cultural factor determining large yields where cotton is grown under irrigation is the application of water at the proper time. This is determined entirely by the development and behavior of the plant, which of course, varies widely with different types of soil. The young cotton plant must be grown with a minimum amount of water until flowering is well begun, after which time the moisture supply must be abundant and uniform, for the plant is then very sensitive to any check that may be brought about by an insufficient moisture supply. After cotton is being formed in the boll, even a slight drought is very depressing to the yield. The fiber from the bolls then requiring most of the sap from the plant will be weak and short. If the drought is severe enough, it will be found at picking time that many bolls are poorly opened. Well-developed bolls may be formed farther out on the branches from late irrigations. However, it should be noted that overirrigation is possible and will cause the cotton plant to shed the flowers after blossoming without setting bolls.

Depression by insufficient irrigation was demonstrated on the experiment farm by three blocks of cotton irrigated at different intervals. Sandy soil that ordinarily would not be chosen for cotton production was selected, in order that contrasts could be sharply shown. The soil drainage was very open, and water escaped quickly, making frequent irrigations possible. Block No. 1 was irrigated every 7 days; No. 2, every 14 days; and No. 3, every 21 days. It was evident that at certain periods blocks Nos. 2 and 3 were suffering from drought, while block No. 1 grew normally and steadily. Plants in blocks 2 and 3 showed lack of water by shedding many squares and bolls and did not develop many bolls until late in the season, when their allotted water application became adequate, as evaporation decreased. Block No. 2 never seemed to be as severely checked as No. 3 and appeared quite like No. 1 in development and production. However, the total season yields showed significant

differences. Block No. 2 yielded no more lint cotton per acre than block No. 3, which produced approximately three-fifths of a bale per acre. Block No. 1, grown under similar conditions but with a uniform moisture supply, yielded 100 per cent more cotton, or one and one-fifth bales per acre.

It can not be said that water application at 7-day intervals is the required irrigation for maximum cotton yields even on this type of soil, but the noteworthy feature of the demonstration is that cotton should not suffer checks from drought while developing fiber, and also that any drought, no matter how short in duration, produces a serious depression in the crop yield.

ALFALFA.

Harvesting alfalfa.—An experiment to determine the effect on hay yields of harvesting alfalfa at different stages of growth was conducted on two series of alfalfa plats, one of a second-year stand comprising 12 quarter-acre plats and another of a first-year crop comprising 8 half-acre plats. The methods were tried in triplicate and duplicate plats, respectively. The first plats were harvested for each crop when the plants were approximately 5 per cent in blossom, the other plat harvests following at 7-day intervals. Table VII shows the comparison of hay yields when harvest was made at these various stages of growth. The yields reported are based on air-dry weights rather than on field-cured weights.

TABLE VII.—*Alfalfa yields obtained in a time-of-cutting experiment at the Yuma Experiment Farm in 1914.*

Field and crop.	Dates of cutting and plat yields.								Mean.
	Plat 1.		Plat 2.		Plat 3.		Plat 4.		
	Date.	Yield.	Date.	Yield.	Date.	Yield.	Date.	Yield.	
Two-year-old field:									
First	Apr. 18	0.598	Apr. 25	0.766	May 2	0.563	May 9	0.708	0.66
Second	May 19	.570	May 27	.825	June 2	.764	June 11	1.583	.94
Third	June 26	.809	July 3	.784	July 10	.756	July 17	.754	.78
Fourth	July 31	.909	Aug. 8	.726	Aug. 14	.533	Aug. 21	.563	.68
Fifth	Aug. 28	.456	Sept. 4	.428	Sept. 11	.424	Sept. 19	.336	.41
Sixth	Sept. 2	.251	Oct. 9	.553	Oct. 16	.431	Oct. 23	.371	.40
Seventh	Dec. 14	.253	Dec. 14	.315	Dec. 14	.278	Dec. 14	.249	.27
Total for season		3.846		4.397		3.749		4.574	4.14
Ratio of first cutting to second cutting	1 : 0.95		1 : 0.108		1 : 0.136		1 : 0.224		1 : 0.141
One-year-old field:									
First	July 7	0.805	July 14	0.67	July 21	0.905	July 30	1.34	0.93
Second	Aug. 14	.46	Aug. 21	.68	Aug. 28	.925	Sept. 24	.715	.70
Third	Sept. 18	.441	Sept. 23	.482	Oct. 2	.311	Oct. 9	.479	.43
Fourth	Nov. 12	.491	Nov. 19	.66	Nov. 27	.788	Dec. 4	.588	.63
Total for season		2.197		2.492		2.929		3.122	2.685
Ratio of first cutting to second cutting	1 : 0.57		1 : 1.01		1 : 1.02		1 : 1.87		

These observations indicate that delaying the harvest of the first crop does not depress the yield of the second crop, but in all cases produces a heavier second crop as the growing period of the first crop is increased; also the total season yield from all plats but one was increased in the same manner. During 1915 this experiment will be continued.

Seeding with a nurse crop.—A common practice of seeding alfalfa in the fall with a grain nurse crop was tested with several grains. Varied seeding rates with bearded barley and Sonora wheat were used. Appler's Rustproof oats succeeded well as a nurse crop on medium light soil when seeded at the rate of 35 pounds per acre. Wheat allowed the development of a better stand of alfalfa than either barley or oats. The seeding rate for wheat as a nurse crop was tested, using 25 to 50 pounds per acre. The best alfalfa stand and a good crop of grain hay were produced with 45 pounds. For light soil, 56 pounds of barley per acre with alfalfa was best, while on heavy soil 30 pounds was sufficient.

Alfalfa seed.—The season of 1914 was not favorable for alfalfa seed production. Generally the highest yields were secured from fields where the first cutting was left for seed. This, however, in previous years, has not been found the best crop for heavy seed yields. The results in seed production from broadcasted and row plantings of varied widths are shown in Table VIII.

TABLE VIII.—*Seed yields of alfalfa sown broadcast and planted in rows of various widths at the Yuma Experiment Farm in 1914.*

Method of seeding.	Variety.	Number of plats.	Cutting saved for seed.	Date cut.	Time to mature.	Yield per acre, cleaned seed.
					Days.	*Pounds.*
Broadcast	Peruvian	2	Second	July 20	94	132
8-inch rows	do	3	do	do	94	118
12-inch rows	do	3	do	do	94	131
16-inch rows	do	3	do	do	94	149
20-inch rows	do	3	do	do	94	192
24-inch rows	do	3	do	do	94	141
28-inch rows	do	3	do	do	94	158
36-inch rows	do	1	do	July 22	153	186
44-inch rows	do	1	do	do	153	211
36-inch rows	do	1	Third	Aug. 13	118	96
44-inch rows	do	1	do	do	118	145
Broadcast	Chilean	1	Second	July 25	110	152
Do	do	1	Third	Aug. 17	91	64

The yields as a whole were low, and no marked differences were found. There was a slight increase in yield as the row space was increased, but this increase was inconsistent. All seed crops taken later in the season than the second cutting are very low and often will not pay for the thrashing.

GRAIN SORGHUMS.

Grain-sorghum variety tests as reported for the season of 1913 were continued during 1914, with a few additional varieties. A series of nine varieties was planted at intervals of 30 days from May 1 to July 1. The yields in bushels per acre are indicated in Table IX.

TABLE IX.— *Yields from nine varieties of grain sorghums grown on the Yuma Experiment Farm in 1914.*

Variety.	Yield of air-dry grain per acre (bushels).					
	May planting.			June planting.	July planting.	Average.
	First crop.	Second crop.	Total.			
White milo	29.7	25.2	54.9	40	30.7	43.6
Dwarf milo	24.2	23.1	47.3	26.6	31.5	35.1
Shallu	18.7	.....	18.7	43.7	31.8	31.4
Feterita	20.5	21.7	42.2	24.9	19.7	28.9
Red kafir	8.5	.....	8.5	15.8	26.2	13.5
Blackhull kafir	11.3	.....	11.3	11.3	24.5	12.3
Dwarf Blackhull kafir	16.9	.....	16.9	10.7	22.5	16.7
White kafir	6.5	.....	6.5	15.9	18.4	13.6
Brown kaoliang	3.5	18.5	22.0	25.6	14.6	20.7

White milo was tested for the first season and proved the heaviest yielder in both the May and June plantings. Dwarf milo produced the next highest yield. Both of these varieties, as well as feterita and brown kaoliang, produced two crops of grain by having the stalks cut away after the first crop was harvested. The average

FIG. 4.—Shallu grown in 3½-foot rows at the Yuma Experiment Farm in 1914.

length of season required by these varieties for maturing grain was as follows: Dwarf milo, 110 days; white milo, 108 days; feterita, 97 days; and brown kaoliang, 90 days.

The kafirs are all somewhat later. Shallu yielded well, but was latest of all, requiring 137 days to mature. Its greatest value is for poultry feed. A plat of shallu is shown in figure 4.

A test was conducted with dwarf milo planted in July to ascertain the distance in the row that this grain should be planted. The results are indicated in Table X, which shows distances in the row from 3 to 36 inches and the relation of the number of stalks per plant to the total yield of thrashed grain, well-matured heads, and chaffy heads.

TABLE X.—*Results of a thinning-space test of dwarf milo at the Yuma Experiment Farm in 1914.*

Thinning distance.	Stalks per plant.	Heads per stalk.			Grain heads in total.	Yield per acre.
		Total.	Grain.	Chaff.		
					Per cent.	*Bushels.*
3 inches	1.39	1.06	1.02	0.04	96.5	45.7
6 inches	1.57	.98	.94	.045	95.3	30.9
12 inches	2.18	.96	.90	.057	94.1	29.7
18 inches	4.04	1.19	1.08	.115	90.4	74.1
24 inches	4.54	1.08	.97	.107	90.0	61.5
36 inches	6.13	1.26	1.02	.024	81.1	49.7

Notably higher yields were obtained from 18-inch thinning, while the 3-inch thinning produced the highest percentage of well-filled heads. The 3-inch thinning was also most uniform in time of ripening. This test will be repeated during 1915.

SUDAN GRASS.

Experimental work with Sudan grass in cooperation with the Office of Forage-Crop Investigations, was extensively increased in 1914. The Sudan-grass hay yields reported are based on air-dry weights. This method allows all yields to be directly compared. When these yields are considered in comparison with field-cured yields, to which the farmer is accustomed, they will first appear small, but they may be made comparable with field yields by increasing the air-dry yields 35.9 per cent. This figure is an average that has been derived from 90 air-dried samples collected in 1914.

Sudan grass was grown in a successive-planting test seeded at 2-week intervals from April 6 to June 23. The heaviest hay yields were secured in three cuttings from plantings made May 2, slightly exceeding the yields of those seeded during April. Sudan grass, like sorghum, does not grow well while the nights remain cool. The best yield, 4.6 tons (or 6.4 tons of field-cured hay) was from broadcast seeding at the rate of 25 pounds of seed per acre. Plantings made in 24-inch rows and cultivated succeeded well this season, contrary to the results of 1913. Sudan grass was also tested in a mixture with Groit cowpeas and Arlington soy beans at different rates of seeding, but as the duplicate plats yielded very inconsistently, this test must be conducted another season. Both of these legumes seem

adapted for such a mixture and produce a remarkably good hay for stock.

Sudan grass, although an annual, has been held three years from the original seeding in field form, due to the two recent mild winters. However, the hay yields have been much lighter than from spring-seeded plats, and this practice is not to be recommended. No difficulty has yet been experienced in eradicating Sudan grass by cultivation.

Plantings for seed production were made in 24 and 44 inch rows and broadcasted at the rate of 20 pounds per acre. Two crops of seed were produced. The results are shown in Table XI.

TABLE XI.—*Yields of Sudan-grass seed at the Yuma Experiment Farm in 1914.*

Method of seeding.	Yields per acre (pounds).		
	First crop.	Second crop.	Total yield.
24-inch rows	420	168	588
40-inch rows	460	248	708
20 pounds broadcast	475	293	768

The second seed crop has sufficient time to mature before destructive frosts occur in a normal season, and it averages about half as great as the yield of the first crop. As the cool nights of autumn set in, Sudan-grass seed has a tendency to become highly colored in red and black shades, which show the unreliability of any arbitrary standard for determining a Johnson-grass admixture in Sudan grass by colors. The fields producing a second crop of highly colored seed produced a first crop of excellent light-colored seed. Dark Sudan-grass seed when stored tends to become lighter in color.

HEMP.

Hemp was grown experimentally both for fiber and for seed. The best yields of fiber were produced from plantings drilled in rows and crossed with a 4-inch drill. Considerable difficulty is encountered in the retting process in this dry climate. Three strains were grown for seed production by different cultural methods, but bird injury was extremely severe and the seed yields were very low. A strain of hemp grown on the experiment farm for three years seemed much better adapted than Minnesota and Kentucky strains grown here for the first season.

FLAX.

Fourteen varieties of flax were planted in May for seed production. The plant development was very poor, indicating that flax can not profitably be grown as a summer crop. However, November plantings are behaving very encouragingly, which suggests the possibility that flax may succeed as a winter crop.

BROOM CORN.

Two varieties of broom corn (Dwarf and Dwarf Standard) were grown from plantings made in June and July. Each variety yielded best from the June planting. Broom corn planted earlier than June is very apt to be uneven in ripening. The yields of brush in tons per acre were as follows: June planting, Dwarf, 0.23; Dwarf Standard, 0.2. July planting, Dwarf, 0.2; and Dwarf Standard, 0.15.

GREEN MANURE.

One of the most important values of alfalfa is its usefulness as a preparatory crop. It is the best green-manure crop yet found when all phases of its benefits are considered. However, a stand of alfalfa is often difficult to establish on very light sandy areas or on spots in fields where heavy grading has exposed the sandy subsoil. Apparently, the difficulty experienced in establishing alfalfa stands on these soils is not a deficiency of plant food, but a very irregular moisture content of the soil. This condition has been found to be most economically improved by the addition of a summer green-manure crop of cowpeas. Cowpeas when planted in a good seed bed have produced on sandy soil approximately 4 tons of green manure per acre. Alfalfa may then be seeded in the fall and become established for the following season.

At the experiment farm the alfalfa yields have been increased 2 tons per acre by this culture. The field operations of growing and plowing under this crop of cowpeas would cost not to exceed $4 per acre. If 2.3 acre-feet of water are applied to this crop at 50 cents per acre-foot, the water will cost $1.16. Cowpea seed has been bought f. o. b. Yuma at $8 per hundred pounds. If planted at the rate of 30 pounds per acre, the seed would cost $2.40, making a total cost of $7.56 per acre for two extra tons of alfalfa, which in 1914, when hay was cheapest, was worth $12.10, netting a profit of $4.54 on the first year's results, as well as the residual effect on the soil. In an effort to determine the best varieties of cowpeas to be grown as a summer green-manure crop, a collection of five varieties was grown under comparable conditions for green-manure production and also tested for seed and hay production. In Table XII are given the relative yields of these varieties.

Of these varieties there are two, the New Era and the Groit, that appear to be distinctly superior to the others in green manure or hay production. If local seed production is to be considered, they are equally valuable for this purpose. Both are early-maturing varieties, the New Era being 7 to 10 days earlier than the Groit. One other variety, however, the Whippoorwill, not included in this test, is known to succeed well under these conditions.

TABLE XII.— *Yields of cowpeas in a variety test at the Yuma Experiment Farm in 1914.*

Variety.	Yields per acre.					
	May planting.			July planting.		
	Green manure	Hay.	Seed.	Green manure.	Hay.	Seed.
	Tons.	*Tons.*	*Pounds.*	*Tons.*	*Tons.*	*Pounds.*
New Era	5.7	1.21	425	4.2	1.00	615
Groit	6.5	1.15	303	3.8	.72	287
Unknown	5.7	.97	175	3.1	.53	219
Black Eye	4.6	.74	118	.95	.....	.....
Clay	3.9	.67	33	2.5	.48	122

WATER REQUIREMENTS.

In the last report of this station, figures showing the approximate water requirements of crops grown during 1913 were recorded. Similar determinations were again made during 1914, and the results are recorded in Table XIII.

TABLE XIII.—*Quantities of water applied to different crops on the Yuma Experiment Farm in 1913 and 1914.*

Crop.	Use of crop.	Water applied (acre-feet).				
		1914.			Average for 1913–14.	
		Light soil.	Medium soil.	Heavy soil.	Light soil.	Medium soil.
Alfalfa	Hay	7.72	5.77	.....	7.8	5.4
Do	Seed	5.34	3.23	.....	.....	.....
Cotton	Fiber	6.4	5.3	.....	6.2	4.5
Grain sorghum:						
Planted in May	Grain	.....	4.5	.....	.....	.....
Planted in July	do	4.9	3.2	.....	5.2	3.1
Hemp	Fiber	.....	5.4	.....	.....	.....
Sudan grass	Hay	.....	6.5	.....	.....	.....
Do	Seed	.....	5.96	.....	.....	.....
Cowpeas	Green manure	4.0	.....	.....	3.2	2.2
Fruits:						
Deciduous fruits	Second year	.....	2.59	.....	.....	.....
Dates	Seedling nursery	.....	5.8	.....	.....	.....
Do	First-year orchard	.....	.....	3.28	.....	.....
Do	Fourth-year orchard	.....	4.02	.....	.....	.....
Figs	do	.....	2.97	.....	.....	.....
Pomegranates	do	.....	2.02	.....	.....	.....

These figures are approximately correct, although a satisfactory method of measuring water for individual fields has not yet been perfected.

ORCHARD EXPERIMENTS.

DATES.

All orchard plantings of seedling date palms enumerated in the report for the year 1913 are continuing to develop normally. Many have flowered, thus making it possible to thin out the superfluous male trees. A total of 713 seedling palms of the Menakher and Tafilet varieties were transplanted to permanent positions. There are now included in this planting a total of 2,400 palms. Very good

results were secured in transplanting seedlings from the nursery to the orchard. Only 2½ per cent of the plants failed to grow. This success can no doubt be attributed to careful preparation of furrows for irrigation before planting, care in setting the crown of the plant well above the earth line, and frequent irrigations. The date palm does not do well if planted deep. This has been the cause of the loss of many palms when transplanted. There are still growing in nursery rows 4,800 palms of the Deglet Noor, Thoory, and Tafilet varieties, to be transplanted to orchard positions later.

FIGS.

The 5-acre block of Smyrna-Adriatic fig hybrids, described in previous reports, came through the winter of 1914–15 with much less frost damage than in previous years. Rooted cuttings were made from a few of the plants that matured the best fruit without the presence of the insect (*Blastophaga psenes*) known to be necessary for the pollinization of the Smyrna fig. An attempt was made to introduce this insect, but without success. Twelve varieties of Adriatic figs were planted in a variety test.

CITRUS FRUITS.

While it is not expected that citrus fruits will survive the possible minimum temperature that may occur in the valley area of the Yuma project, a small collection of citrus varieties was planted. There are included in this collection five varieties of oranges, three of lemons, one of grapefruit, two of tangerines, and one of kumquat.

DECIDUOUS FRUITS.

The variety planting of deciduous fruits made in 1913 has developed extremely good growth. A record of averages of growth is presented in Table XIV.

TABLE XIV.—*Growth of deciduous fruits at the Yuma Experiment Farm in 1914.*

Fruit.	Number of varieties.		Number of trees.		Average growth measurements.					
					1913			1914		
	1913	1914	1913	1914	Extreme height.	Season growth.	Trunk diameter.	Extreme height.	Season growth.	Trunk diameter.
					Feet.	*Feet.*	*Inches.*	*Feet.*	*Feet.*	*Inches.*
Peach	31	19	53	57	5.4	3.8	1.12	9.9	6.3	3.0
Plum	16	12	23	23	4.7	3.3	1.05	8.3	4.9	1.9
Prune	6	4	9	7	6.3	3.2	1.2	7.2	4.2	1.5
Apricot	4	3	5	3	6.0	3.6	1.1	9.6	5.3	2.6
Nectarine	1	1	2	2	8.4	3.7	2.4	8.9	5.3	2.8
Cherry	7	.....	12	.....	.....	.....	.....	6.4	3.03	1.19
Pear	10	19	16	48	3.9	2.2	.75	6.1	3.2	1.3
Apple	6	8	13	31	4.1	2.1	.82	6.9	4.2	1.67
Quince	3	1	6	2	4.8	3.2	.80	7.2	4.1	1.06
Pecan	3	3	5	6	1.4	.39	.25	1.6	.42	.48
Walnut	3	3	6	3	2.7	.35	.69	7.1	1.9	1.52
Almond	4	1	8	8	4.8	3.0	.78	7.1	4.4	2.0
Pistache	10	1	31	2	5.3	2.9	.87	5.3	1.95	2.0
Persimmon	12	2	20	6	1.7	.75	.43	3.5	1.3	.....

This variety test has been increased by the addition during 1914 of 19 varieties of peaches, 12 of plums, 5 of apricots, 1 of nectarine, 19 of pears, 8 of apples, 1 of quince, 3 of pecans, 3 of walnuts, 1 of almond, and 2 of Japanese persimmons. There are also included in this orchard several species of fruit-bearing trees of foreign introduction under test either for fruit production or as a stock for propagating fruit varieties now being cultivated. Peach and Sugar-prune trees are shown in figures 5 and 6.

A very destructive disease of the pomegranate fruit commonly occurring in this locality about ripening time has damaged much

FIG. 5.—A Mexican seedling peach tree, S. P. I. No. 32379, 21 months old, at the Yuma Experiment Farm in 1914.

fruit for the past two years. So far as the writer is able to learn, this disease has never been identified. The injury resembles that of a parasitic fungus. An attempt to control this disease by the application of a Bordeaux-mixture spray resulted rather encouragingly and will be tested further another season.

VEGETABLES.

The results of experiments in vegetable culture given in the report of this station for 1913 have been supplemented with some further tests of varieties and culture of those vegetables that may best be

grown on a large acreage, considering marketing opportunities. Onions grown on the bed systems seeded November 6 and harvested July 16 to 23 yielded as follows: Crystal Wax, 35,734 pounds per acre; White Australian, 32,964 pounds per acre; Australian Brown,

FIG. 6.—A sugar prune tree, 20 months old, at the Yuma Experiment Farm in 1914.

19,298 pounds per acre; and Prizetaker, 7,202 pounds per acre. Sweet potatoes of the White Vineless variety yielded at the rate of 7.57 tons per acre. Table XV includes data secured in a variety test of tomatoes.

TABLE XV.—*Yields in a variety test of tomatoes at the Yuma Experiment Farm in 1914.*

Variety.	Date planted.	Date of first picking.	Yield per acre.
			Pounds.
A. & M. First Early	Mar. 24	June 17	32,670
Sparks' Earliana	...do.....	June 13	21,690
June Pink	...do.....	...do.....	21,030
Burpee's Matchless	...do.....	June 24	18,100
M. & S. Coreless	...do.....	June 29	15,950
Burpee's Dwarf Giant	...do.....	June 17	10,700
Burpee's Quarter Century	...do.....	...do.....	8,340

The variety A. & M. First Early proved the best yielder, although it was not so early as Sparks' Earliana or June Pink. It is a very good variety for the market. Sparks' Earliana and June Pink both

yielded heavily, but they are difficult to ripen in this climate, the former decaying badly if not staked, and the latter being very susceptible to sun scald and decay.

In a variety test the watermelons found best adapted to this region and planted February 2 produced yields as shown in Table XVI.

TABLE XVI.—*Yields in a test of commercial varieties of watermelons at the Yuma Experiment Farm in 1914.*

Variety.	Date of first ripe melons.	Number of melons per acre averaging—			Total yield per acre.
		7 pounds.	15 pounds.	22 pounds.	
					Tons.
Klondike	June 12	307	1,135	749	17.82
Black-Seeded Chilean	do	635	1,323	365	16.16
White-Seeded Chilean	June 14	542	803	677	15.36
Kleckley Sweet	June 12	743	629	200	9.51
Brazilian	June 29	250	250		2.75

The four heaviest producers are all of excellent quality. Black-Seeded Chilean and Kleckley Sweet are perhaps the best early melons. Melons started in paper pots and transplanted produced lower yields than those seeded in the field. In addition to the popular commercial varieties of melons grown, four varieties of watermelons and 29 varieties of muskmelons of foreign introduction were grown. Of this collection, one watermelon variety and six varieties of muskmelons proved worthy of further trial.

ORNAMENTALS.

Most of the collection of ornamental trees and shrubs planted on the experiment-farm grounds in the spring of 1913 have made excellent growth. Some few species of the collection could not endure the severe summer heat. Very few were damaged by frost during the winter. This collection was increased extensively by additional plantings during 1914. Among these were several additional species of ornamental palms and other evergreens, as well as deciduous plants. One mile of farm fence line was planted to small trees of the desert gum (*Eucalyptus rudis*). This completes the planting of all sides of the experiment farm to this tree. Adjacent to this row of trees is a 25-foot road, encompassing the farm, the interior road line being planted to a row of seedling date palms. These palms are now growing on three sides of the farm.

The desert-gum trees, which were frozen to the ground in January, 1913, when measured in November, 1914, had an average height of 13 feet 2 inches and an average trunk diameter of 2.035 inches.

A block of seven species of eucalyptus thought to be the best adapted to this climate was planted, to provide for comparable observations of growth and frost resistance.

Among the herbaceous flowering plants to be grown in this region it has been found that few, if any, are superior to the chrysanthemum. During the past season a collection of 61 of the best-known varieties was tested, of which 52 grew well, 14 of these being notably superior.

FIG. 7.—A chrysanthemum variety planting at the Yuma Experiment Farm in 1914.

These varieties are listed in Table XVII, in which the colors and date of maximum flowering are also indicated. A view of the chrysanthemum planting is shown in figure 7.

TABLE XVII.—*Results secured in a chrysanthemum variety test at the Yuma Experiment Farm in 1914.*

Variety.	Color.	Date of maximum flowering.	Variety.	Color.	Date of maximum flowering.
E. L. Brooks	Red	Nov. 13	La Provence	Old gold and yellow.	Nov. 24
L. Africane	Deep red	do			
W. Meade	Light red	Nov. 24			
Harvard	Maroon	do	Valserre	Yellow	Nov. 13
Nurgrie	Dark pink	Nov. 19	Ramapo	do	Nov. 19
Amarantha	do	do	Crown Princess	do	Do.
Ethel Thorpe	Light pink	Nov. 13	Mrs. Percy Wiseman	Cream	Nov. 24
Rose Prockett	Old gold	Nov. 19	Mrs. Gilbert Drabble	White	Do.

The chrysanthemum behaves as a perennial when planted in open beds, the roots surviving for several seasons, but the best flowers will be obtained where the roots are divided and replanted early each spring.

Bamboo plantings passed the winter of 1914–15 with little frost injury. Two species, *Dendrocalamus strictus* and *Bambos arundinacea*, are established in the experiment-farm garden. The former has made the heavier growth.

Approved:

WM. A. TAYLOR,
Chief of Bureau.

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